ELEVATED RISK OF TYPE 2 DIABETES AND METABOLIC SYNDROME AMONG ASIANS AND SOUTH ASIANS: RESULTS FROM THE 2004 NEW YORK CITY HANES

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Objective: Although numerous studies have identified an elevated risk of diabetes or impaired fasting glucose among Asians, there are limited data examining variability in risk among Asian subpopulations. We estimated prevalence of diabetes (DM), metabolic syndrome (MS) and impaired fasting glucose (IFG), by race/ethnicity and by Asian subgroup.

Design, settings and participants: This study was conducted using the fasting subsample of the 2004 New York City Health and Nutrition Examination Survey (NYC HANES; n=1,324), a local version of the NHANES. Using country of origin information, we constructed South Asian and other Asian categories.

Main outcome measures: DM, MS and IFG.

Results: Age-standardized prevalence estimates of DM, MS and IFG were 10.8%, 13.3% and 21.4% among Whites, 16.1%, 12.0% and 32.4% among all Asians, and 35.4%, 17.7% and 15.9% among foreign-born South Asians, respectively. After adjusting for potential confounders, Asians had significantly higher odds of prevalent IFG (Adjusted odds ratio [AOR]:2.64; 95% confidence interval [CI]: 1.60–4.38) and MS (AOR:2.09; 95%CI: 1.19–3.68), compared to Whites. South Asians were more likely to have DM (AOR:4.88; 95%CI: 1.52–15.66) and MS (AOR:5.59; 95%CI: 1.69–18.50) compared to Whites, while other Asians were at increased prevalence of IFG (AOR:2.89; 95%CI: 1.65–5.07).

Conclusion: Our findings suggest that the observed White/Asian disparity in DM risk may be primarily attributable to elevated risk among South Asians. (*Ethn Dis*. 2010;20:225–230)

Key Words: Diabetes, Metabolic Syndrome, Impaired Fasting Glucose

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INTRODUCTION

Type 2 diabetes (DM) is a global epidemic and a major public health concern in the United States. Having diabetes elevates the risk of developing cardiovascular disease (CVD).[1] In addition, diabetes is associated with a high economic burden that is attributable to direct healthcare costs and indirect costs associated with morbidity and premature mortality.[2] People with impaired fasting glucose (IFG) and metabolic syndrome (MS), as defined by the Adult Treatment Panel (ATP) III criteria,[3] are at an elevated risk of developing diabetes as well as CVD.[4–5] Multiple studies in the United States suggest that Asians are at particularly high risk of developing diabetes.[6–9] There is also some evidence to suggest that South Asians are particularly prone to develop diabetes and CVD,[6,10–12] although US data in this regard are limited since most existing studies combine all Asians into one category.[7–8]

In New York City (NYC), there are currently as many as one million Asian Americans (10% of total NYC population) and this number is expected to rise in the next decade.[13–14] Within that population, there is wide variability in national origin, as well as the cultural, dietary, and lifestyle factors, several of which are important determinants of cardiometabolic risk. This provides an opportunity for investigating diabetes risk among different Asian subgroups. The size and diversity of the NYC population allow us to reliably estimate disease risk not only among Asians overall, but also among Asian subgroups. We conducted the current study to estimate the difference in risk for diabetes and other cardiovascular risk factors between Whites and Asians overall, as well as South Asians and Asians from other countries. Data are from the New York City Health and Nutrition Examination Survey (NYC HANES). These data will be useful to local planners, as well as researchers and policy makers in other US jurisdictions with Asian populations to develop cost-effective strategies that will help to prevent or delay the onset of diabetes.

We conducted the current study to estimate the difference in risk for diabetes and other cardiovascular risk factors between Whites and Asians overall, as well as South Asians and Asians from other countries.

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METHODS

Survey Design and Sample

The NYC HANES was a population-based, cross-sectional examination survey of non-institutionalized NYC adult residents aged ≥20 years, conducted from June to December 2004. Survey components consisted of a physical examination, laboratory tests, and personal interviews. Detailed information on the survey design is published elsewhere.[15] In brief, NYC HANES was modeled after NHANES[16] and conducted using three-stage probability sampling. The overall response rate for NYC HANES was 55%.[15] Of the 1,999 study participants, a random sample of 80% were assigned to fast for 8 hours and prioritized for a morning clinic appointment. Adults not assigned to fast but who did so voluntarily (n=136) were comparable to those assigned to fast on all demographic characteristics except age and were included in the fasting sample (n=1,350). Pregnant women (n=12) and participants with unknown diabetes status (n=14) were excluded. Our final sample size was 1,324.

Anthropometric measurements, including height, weight, and waist circumference, were taken using standardized NHANES protocols and definitions.[16] Body mass index (BMI) was defined as weight in kilograms divided by squared height in meters. For each participant, up to four systolic and diastolic blood pressure measurements were taken and the average was reported, excluding the first reading and diastolic readings of zero. Self-reported health risk behaviors included current smoking and sedentary lifestyle, which was defined as fewer than 10 minutes of either vigorous or moderate activity per day in the past 30 days.[17]

Blood specimens were collected and processed according to NHANES protocols.[15] Fasting plasma glucose was measured at the University of Missouri Diabetes Diagnostic Laboratory. Lipid profiles were analyzed at the Lipoprotein Analytical Laboratory at Johns Hopkins University Hospital. All NYC HANES protocols and informed consent procedures were reviewed and approved by the New York City Department of Health and Mental Hygiene Institutional Review Board.

Diagnosis of Diabetes, Impaired Fasting Glucose and Metabolic Syndrome

Participants were considered to have diabetes if: 1) they reported that a healthcare professional had ever told them they had diabetes, excluding gestational diabetes or borderline diabetes; or 2) they had a fasting plasma glucose (FPG) level ≥126 mg/dL.[18] Impaired fasting glucose (IFG), defined as a FPG of 100–125 mg/dL, and MS were assessed among non-diabetic participants only.[18] Based on the modified Adult Treatment Panel (ATP) III criteria,[3] MS was defined as the presence of ≥3 of the following: 1) elevated triglycerides (≥150 mg/dL), 2) low HDL-cholesterol levels (men <40 mg/dL and women <50 mg/dL), 3) IFG, 4) elevated blood pressure (treated hypertension, systolic blood pressure ≥130 mm Hg or diastolic blood pressure ≥85 mm Hg), or 5) elevated waist circumference (≥102 cm for men and ≥88 cm for women). Non-diabetic participants whose MS status could not be definitively classified were coded as missing on the MS outcome (n=17).

Assessment of Race/Ethnicity

Participants self-reported their race/ethnicity as non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic, or other. Multiracial respondents were asked to select a main race and were assigned to that selected category. Participants also reported their country of birth. We classified Asians as foreign-born or US born, which includes US territories. Foreign-born Asians were separated into two groups: (1) South Asians, including those born in Bangladesh, India, Nepal, and Pakistan; and (2) other Asians including those born in Canada, China, Ghana, Guyana, Hong Kong, Japan, Kazakhstan, Kyrgyzstan, Macau, Myanmar, North Korea, Philippines, South Korea, Trinidad and Tobago, Taiwan, Thailand, and Viet Nam.

Statistical Analysis

Survey data were weighted to account for differential selection probabilities and survey non-response; weights were post-stratified to the adult population of NYC based on age group, sex, race/ethnicity and borough. Analytic weights were further adjusted based on race/ethnicity, age group, and sex to account for item non-response on the DM, IFG and MS outcomes. All data analysis was performed using SUDAAN version 10.0 (Research Triangle Institute, Research Triangle Park, NC) to account for complex survey design. Age-standardized prevalence estimates and their relative standard errors (RSEs) were calculated. We compared means (for continuous variables) and proportions (for categorical variables) of sociodemographic characteristics and CVD risk factors by race/ethnicity. Further, we conducted logistic regression analysis to determine if Asian race/ethnicity was associated with increased odds of prevalent DM, MS or IFG compared to non-Hispanic Whites.

We developed two sets of multivariable models: 1) combining all Asians together (including US born) into a single group; and 2) foreign-born Asians only, classified as South Asian or other Asian. Since ancestry was only assessed among foreign-born participants and most Asians (95%) in the NYC HANES sample were foreign-born, foreign-born status was not included as a covariate in the multivariable models. Adjusted odd ratios (AORs) and 95% confidence intervals (CIs) were estimated using the logistic procedure. We considered several sociodemographic

Table 1. Distribution of sociodemographic and anthropometric characteristics by race and ethnicity in NYC HANES

Characteristic	All*	Whites	Blacks	Hispanics	Asians	Foreign-born Asians born in South Asia	Foreign-born Asians not born in South Asia
N	1,324	382	287	475	160	37	113
Age in years , mean (SE)	45.7 (.8)	48.6 (1.3)	45.9 (1.5)	43.1 (1.1)	42.2 (1.5)	39.3 (3.0)	44.4 (1.7)
Sex, % female	53.5	49.2	56.1	58	51.4	42.4	53.4
Income <$20,000, %	31.5	17.7	33.2	49.4	34.5	28.2	38.6
Foreign-born, %	48	29.7	36.6	65.2	94.6	-	-
Uninsured, %	22.3	12.7	22.2	34.4	30.4	26.3	31.4
Current smokers, %	24.5	24.8	25.1	24	23.1	16.7	23.7
% sedentary lifestyle	23.4	20.3	19.8	28.5	29.1	48.9	25.2
Family history of diabetes, %	29.2	21.6	38.8	32.2	28.6	33.7	27.9
BMI ($kg/m^{2)}$							
Mean (SE)	27.4 (.2)	26.8 (.3)	29.0 (.5)	28.1 (.3)	24.5 (.4)	25.9 (.7)	23.7 (.3)
<18.5, %	2.2	2.6	1.2	1.3	4.3	0	6
18.5–24.9, %	36.2	42.3	27.9	24.2	60.6	58.8	63.4
25.0–29.9, %	36.4	33.8	38.5	42.3	27	28.8	27
≥30, %	25.3	21.4	32.4	32.2	8.2	12.4	3.6
Waist circumference, cm							
Mean (SE)	95.3 (.5)	95.4 (.8)	97.8 (1.1)	96.0 (.6)	88.4 (1.0)	92.6 (1.7)	86.4 (1.0)
% elevated†	45.5	42.9	51.7	53.1	24.6	32.9	18.3

* All group also includes those who reported other race/ethnicity ($n=20$). Estimates for other race/ethnicity are not presented due to small sample size. Pregnant women are excluded.

† Waist circumference >102 cm in men and >88 cm in women.

and lifestyle variables as potential confounders. The final multivariable models included variables that are known risk factors for diabetes (age, BMI, family history of diabetes and sedentary lifestyle)[19] and those that were associated with both race and diabetes risk in this study population (income and insurance status). All statistical tests conducted were two-sided and *P*-values less than .05 were considered statistically significant.

RESULTS

We found that compared to non-Hispanic Whites, Asians were slightly younger, and more likely to be uninsured, have a sedentary lifestyle and have annual income <$20,000 (all $P<.05$) (Table 1). Approximately 30% of non-Hispanic Whites and 95% of Asians living in NYC were born outside the United States. Asians had a significantly lower BMI and waist circumference than non-Hispanic Whites, Blacks and Hispanics ($P<.05$). Among foreign-born Asian populations, South Asians had a significantly higher prev-

Table 2. Age-standardized prevalence of diabetes, impaired fasting glucose and metabolic syndrome by race and ethnicity, excluding pregnant women

	Diabetes†		MS‡		IFG§	
	n Cases	Age-adjusted prevalence (SE)	*n* Cases	Age-adjusted prevalence (SE)	*n* Cases	Age-adjusted prevalence (SE)
All *	131	12.5 (1.2)	212	17.0 (1.2)	278	23.6 (1.3)
Whites	32	10.8 (1.9)	49	13.3 (1.9)	80	21.4 (2.0)
Blacks	37	14.6 (2.7)	44	18.0 (2.7)	53	21.6 (2.9)
Hispanics	41	12.3 (2.1)	97	23.0 (2.3)	99	25.3 (2.6)
Asians	20	16.1 (4.1)	20	12.0 (2.3)	43	32.4 (4.2)
Foreign-born Asians	18	15.4 (3.9)	19	12.1 (2.4)	41	32.7 (4.2)
Born in South Asia	8	35.4 (9.7)	7	17.7 (5.9)‖	7	15.9 (5.4)‖
Not born in South Asia	10	10.8 (4.0)‖	12	9.6 (2.6)	34	36.9 (4.9)

* All group also includes those who reported other race/ethnicity ($n=20$). Estimates for other race/ethnicity are not presented due to small sample size.

† Diabetes defined as self-reported physician diagnosis and treatment or a fasting plasma glucose ≥126 mg/dL.

‡ Metabolic syndrome (MS) defined by ATP III criteria for participants without diabetes.

§ Impaired fasting glucose defined as plasma glucose of 100–125 mg/dL for participants without diabetes.

‖ Unreliable estimate due to relative standard error >30%.

Table 3. Odds ratio (95% confidence intervals) for prevalent diabetes, impaired fasting glucose (IFG) and metabolic syndrome (MS) comparing Asians to Whites

	Multivariable models*		
	Model 1	Model 2	Model 3
Outcome	Adjusted for age and sex	Model 1 + BMI	Model 2 + smoking, sedentary lifestyle, income, insurance status and family history of diabetes
Diabetes	1.70 (.77, 3.72)	2.39 (1.09, 5.22)	1.86 (.86, 4.03)
MS†	1.12 (.66, 1.90)	1.92 (1.09, 3.39)	2.09 (1.19, 3.68)
IFG†	2.17 (1.35, 3.49)	2.68 (1.63, 4.40)	2.64 (1.60, 4.38)

* Reference category is non-Hispanic Whites.
† Participants with diabetes were excluded.

alence of elevated waist circumference compared to rest of the foreign-born Asians (32.9% vs. 18.3%). In addition, South Asians were less likely to smoke and more likely to have a sedentary lifestyle compared to other Asians.

Table 2 shows the age-standardized prevalence of DM, MS and IFG by race/ethnicity. There were no significant differences in prevalence of DM, IFG or MS between Asians overall and Whites. However, compared to Whites, South Asians had a significantly higher prevalence of diabetes (35.4 vs 10.8; P=.013), and other Asians had significantly higher prevalence of IFG (36.9 vs 21.4; P=.005).

Adjusted odds ratios comparing all Asians to Whites are presented in Table 3 for each of the three outcomes. In the model adjusting for age and sex (Model 1), Asians were at an elevated risk for IFG (AOR: 2.17; 95% CI: 1.35–3.49), but not for diabetes or MS, compared to Whites. However, when we accounted for BMI (Model 2), Asians were twice as likely as Whites to have all the three conditions; (AOR=2.39;(95% CI: 1.09–5.22) for diabetes, (AOR:1.92; 95% CI: 1.09–3.39) for MS and (AOR: 2.68; 95% CI: 1.63–4.40) for IFG. Although further adjustment for health risk behaviors, insurance status, and family history of diabetes attenuated the risk of DM (Model 3), statistically significant differences in odds of MS and IFG persisted. When we further classified Asians by region of birth (Table 4), Asians born in South Asia were nearly five times as likely to have diabetes (AOR: 4.88; 95% CI: 1.52–15.66) and five times more likely to have MS (AOR: 5.59; 95% CI: 1.69–18.50), compared to Whites. Other foreign-born Asians were at increased risk for IFG compared to Whites (AOR: 2.89; 95% CI: 1.65, 5.07) but were not at an increased risk of diabetes or MS compared to Whites.

Table 4. Multivariable OR (95% CI) for prevalent diabetes, impaired fasting glucose (IFG) and metabolic syndrome (MS) comparing Asians born in South Asia and other foreign-born Asians to Whites

	Multivariable models* (adjusted for age, sex, body mass index, smoking, sedentary lifestyle, income, insurance status and family history of diabetes)	
Outcome	Asians born in South Asia	Other foreign-born Asians
Diabetes	4.88 (1.52, 15.66)	1.08 (.44, 2.62)
MS†	5.59 (1.69, 18.50)	1.53 (.80, 2.94)
IFG†	1.81 (.67, 4.89)	2.89 (1.65, 5.07)

* Reference category is non-Hispanic Whites.
† Participants with diabetes were excluded.

DISCUSSION

This study used data from a population-based examination survey to estimate the prevalence of diabetes, and two of its primary risk factors, MS and IFG, among New York City adults by race/ethnicity and among foreign born Asians by region of origin. After controlling for BMI and multiple demographic, medical and behavioral risk factors, Asians were at increased risk for IFG and MS compared to Whites. However, risks among South Asians and other Asians differed significantly. South Asians had about five times the odds of having DM and MS, and other Asians were at increased risk of IFG, but not MS and DM. In addition, we found important differences in risk factors for DM: sedentary lifestyle and obesity were far more common among South Asians than other Asians.

South Asians had about five times the odds of having diabetes mellitus and metabolic syndrome, and other Asians were at increased risk of impaired fasting glucose, but not metabolic syndrome and diabetes mellitus.

Our exam-based results are consistent with self-reported national data from the 2001 Behavioral Risk Factor Surveillance System (BRFSS), where statistically significant differences in diabetes risk between Whites and Asians were observed only after BMI was added to the model.[8] That Asians are at significantly increased risk for IFG and MS after adjusting for BMI and behavioral risk factors suggests that unmeasured cultural or biological differences may partially explain these disparities in CVD risk. We hypothesize that IFG progresses to DM at different rates in different Asian subgroups which may partly explain the high prevalence of IFG but not of DM among other Asians. However, this possibility warrants further investigation.

Obesity, the strongest known risk factor for the development of type 2 diabetes, has been found to be more detrimental among Asians compared to other ethnic groups when examining diabetes risk.[20] In a Canadian study,[21] investigators reported that for every given level of BMI, Asians had higher plasma glucose and glycosylated hemoglobin (HbA1c) compared to Whites. Several reports suggest that the BMI cut-offs derived mainly based on studies among predominantly White populations may not be appropriate for Asians.[22–24] Deurenberg et al[22] reported that for a given percent body fat, Asians have a BMI that is 3–4 kg/m^2 lower than in Whites. Furthermore, compared to Whites, Asians have higher levels of visceral or intra-abdominal fat, a potentially stronger predictor of insulin resistance and diabetes risk compared to total body fat.[25–28] In a study comparing visceral fat in Asian Americans to European Americans, Park et al[27] reported that Asian American women had higher visceral fat compared to European women (.85 vs .51 kg; P=.0002) even after adjusting for age and total body fat.

Overall, our findings begin to display the complexity of disparities in cardiometabolic risk for CVD within the increasingly diverse Asian American population. However, further research will require larger studies with the inclusion of adequate numbers of individuals belonging to multiple Asian subgroups. While NYC HANES provides examination data for the first local population-based sample of Asians in the United States, one key limitation of the data is the small sample size of South Asians. However, since comparable national data are unavailable, these data are a particularly useful addition to this line of research. Another potential limitation is misclassification of country of birth and race/ethnicity because we defined foreign-born Asian status based on self-reported information, though we have no plausible concerns for why incorrect information might be disclosed. Other limitations of the NYC HANES data may include recall bias and measurement error in the examination components. However the study strictly adhered to widely accepted quality assurance procedures from NHANES protocols.[16] Item and component non-response bias was minimized through use of post-stratification survey weights.[16]

In conclusion, we found that Asians living in NYC were at an elevated risk of IFG and MS compared to Whites. South Asians were at elevated risk of diabetes and MS, while other Asians were at elevated risk of IFG. The high prevalence of IFG and MS in Asians and the increasing Asian population in NYC suggest that NYC will experience an increased burden of diabetes in the next few decades. Given the diversity within the Asian American population, appropriately sized studies are required to estimate the risk factors and burden of disease in different Asian subgroups. Our data suggest that cardiovascular risks differ by countries of origin, and policies and programs aimed to reduce these conditions should target groups differently, recognizing risk factors beyond traditionally noted conditions such as obesity. Since the Asian American population is rapidly increasing in the United States, there is enormous potential to reduce premature CVD mortality by expanding efforts to reduce the burden of this disease in this population.

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